E. *coli* and Fecal Coliform in Recreational Waters

SOLEC Indicator #4081

Purpose

To assess E. *coli* and fecal coliform contamination levels in nearshore recreational waters, acting as a surrogate indicator for other pathogen types and to infer potential harm to human health through body contact with nearshore recreational waters.

Ecosystem Objective

Waters should be safe for recreational use. Waters used for recreational activities involving body contact should be substantially free from pathogens, including bacteria, parasites, and viruses, that may harm human health. This indicator supports Annexes 1, 2 and 13 of the GLWQA.

State of the Ecosystem

Beach water quality is monitored using two methods: counts of either E. *coli* and/or fecal coliforms (FC) in recreational waters measured as number of organisms per volume of water (e.g., FC/ml). When the bacteria standards are exceeded, local authorities may restrict swimming or issue advisories of unsafe water.

Frequency of beach postings at specific locations are reported annually and become the basis for determining the risk for safe recreational use, i.e., the percent of swim season individual beach waters have not been closed or restricted due to bacterial contamination and/or other environmental condition, including pre-emptive swimming closings based on past experience. Not all advisories, however, are due to bacterial contamination.

Survey reports of U.S. beach advisories during the 1998 swimming season (June, July, August) show that 81.2% of the respondents has some form of monitoring in use, and 78.4% were open for the entire 1998 season. Results were similar for Canadian beaches where 78% of the reported beaches were open the entire season (Figure 1). The distribution of the number of beaches for which advisories were issued for one, two, three, etc., days during the 1998 season shows that most beaches were open most of the season, and only a relatively few were closed 10 days or more (Figure 2).

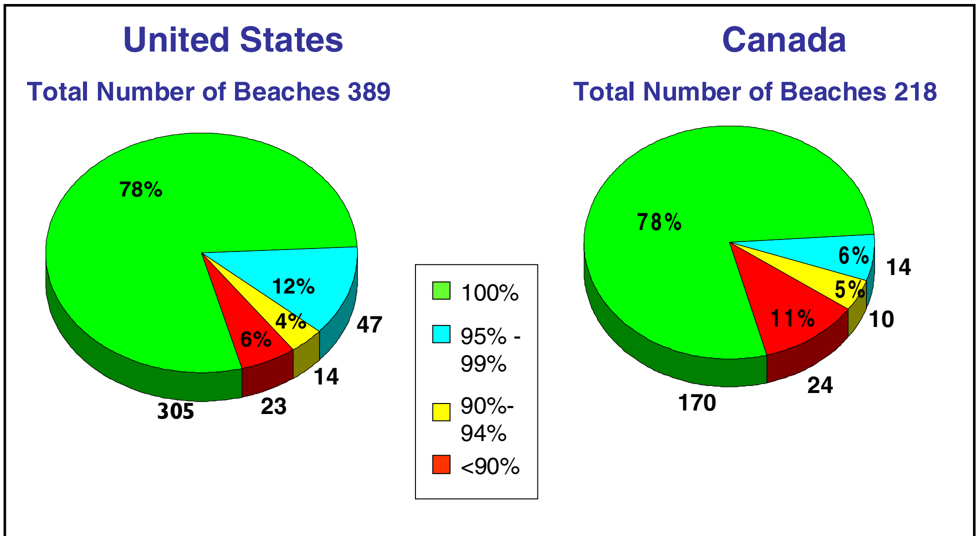

Figure 1. Percentage of Great Lakes beaches open for swimming (June-August 1998)

Survey reports of U.S. breach closings or advisories during the 1999 season show that 76.7% of the respondents had some form of monitoring in use and that 65.2% were open for the entire 1999 season (Figure 3). Several factors may have influenced the apparent increase in percentage of beach closings in 1998 compared with 1998. 1) Fewer beach managers responded to survey questionnaires in 1999, and of those beaches that were reported, not all had been included in the 1998 data. Therefore, the underlying population of beaches were not exactly the same between years. 2) More beach managers were using E. *coli* testing in 1999 than in 1998. E *coli* is a more sensitive indicator of public health risks for swimmers, and it gives more consistent results. Its increased use as an indicator of bacterial contamination of swimming water is expected to result in more frequent swimming advisories to protect public health. 3). A change in accounting the number of beach advisory days in 1999 resulted in reports of beaches closed for two or three days in circumstances that would have been tallied as one or two days in 1998.

Future Pressures on the Ecosystem

Future growth of cities will increase the demands made on sewage treatment plant capacities, increasing the

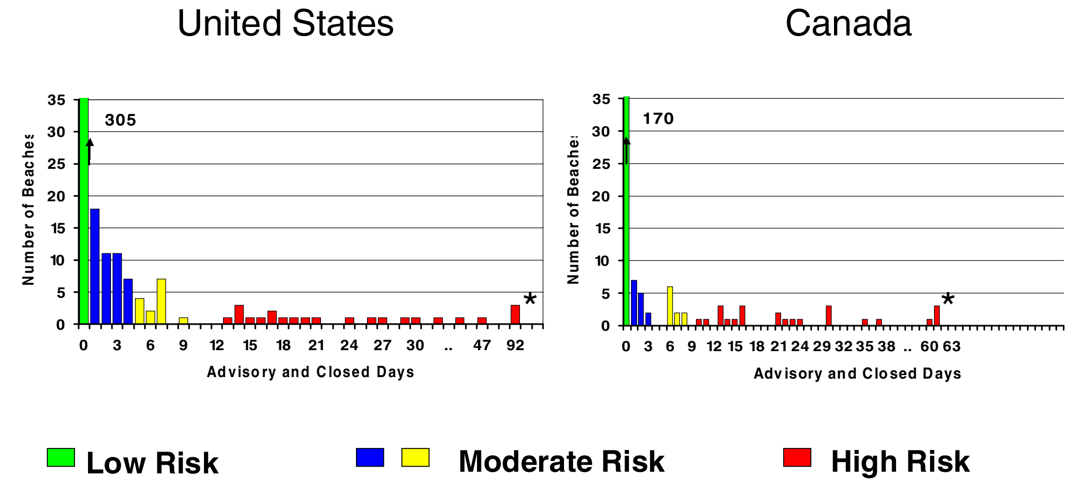

Figure 2. Great Lakes swimming advisories and closings 1998.

probability of release of untreated effluent. An increase in resort/vacation areas utilizing private systems, such as septic fields and cess pools, will likely increase undetected releases of inadequately treated waste. There is an uncertainty of available funding to carry-out beach monitoring and sanitary system capacity.

Future Activities

The experiences of the beach managers in the metropolitan areas of Chicago and Toronto have demonstrated two important elements to successful beach operations: active beach management, and communicating public health risks.

Beaches must be actively managed to provide benefits to the maximum number of users while minimizing potential risks to human health. Management may include infrastructure design such as groins, piers or revetments, and it may include daily (or more frequent) maintenance such as raking, trash pick-up, pet restrictions, and warnings to avoid the splash zone. Beaches may remain open for use even while under a swimming advisory.

Communicating public health risks may involve multiple forms of communication, including news media, telephone hot line, electronic web sites, posted notices at the beach, flags (such as used for storm warnings), and lifeguards. The message should be clear and consistent, i.e., "Swim" or "Don't Swim." Accurate information is needed, based on one objective standard, delivered by credible spokespersons.

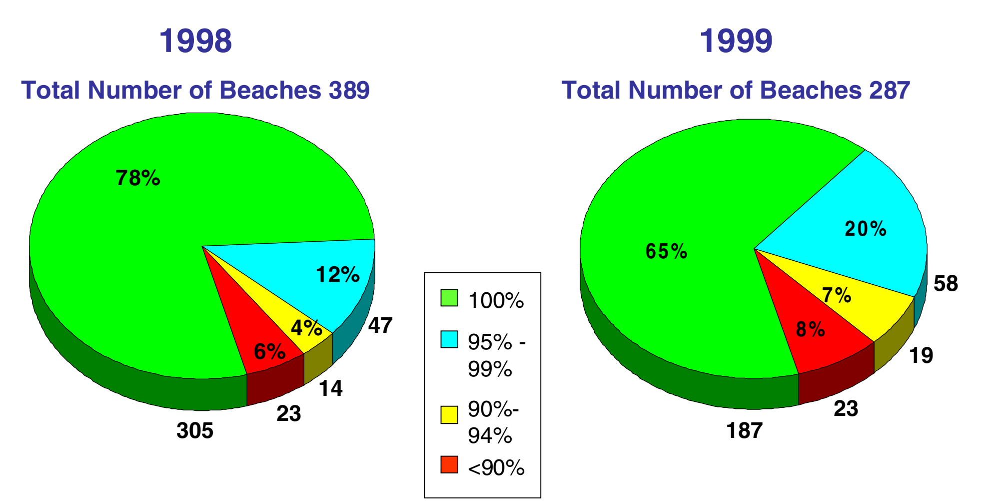

Figure 3. Percentage of U.S. Great Lakes beaches open for swimming (June-August).

Further Work Necessary

To fully implement this indicator, and to ensure the maximum enjoyment of Great Lakes beaches by the greatest number of people with the minimum risks to human health from exposure to bacterial contamination, the following elements are required:

C Universal adoption and application of E. *coli* testing and standards. All beaches should follow uniform protocols.

- C Development of rapid E. *coli* testing procedures that would allow beach managers to receive results within two hours of sampling water at beaches. Such data would facilitate real-time decisions concerning advisories to protect human health.
- C Frequent application of a rapid E. *coli* testing procedure. Because the procedure is quick, multiple testing can be performed during the swimming day, and swimming advisories adjusted as needed.
- C Universal reporting of beach advisories. All beaches on the Great Lakes shoreline should participate, and reporting should be timely and complete.

Acknowledgments
The following personnel contributed data, analysis, or reporting expertise to this indicator:
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Chemical Contaminants in Edible Fish Tissue

SOLEC Indicator #4083

Purpose

Assess the historical trends of the edibility of fish in the Great Lakes using fish contaminant data and a standardized fish advisory protocol. The approach is illustrated using the Great Lakes protocol for PCBs as the standardized fish advisory benchmark applied to historical data to track trends in fish consumption advice. US EPA GLNPO salmon fillet data and MOE data are used as a starting point to demonstrate the approach.

Ecosystem Objective

Overall Human Health Objective: The health of humans in the Great Lakes ecosystem should not be at risk from contaminants of human origin.
Fish and wildlife in the Great Lakes ecosystem should be safe to eat; consumption should not be limited by contaminants of human origin.

Annex 2 of the GLWQA requires LaMPs to define "…the threat to human health posed by critical pollutants…including beneficial use impairments."

State of the Ecosystem

Since the 1970's, there have been declines in many persistent bioaccumulative toxic (PBT) chemicals in the Great Lakes basin. However, PBT chemicals, because of their ability to bioaccumulate and persist in the environment, continue to be a significant concern.

Fish Consumption Programs are well established in the Great Lakes. States, tribes, and the province of Ontario have extensive fish contaminant monitoring programs and issue advice to their residents about how much fish and which fish are safe to eat. This advice ranges from recommendations to not eat any of a particular size of certain species from some water bodies, to recommending that people can eat unlimited quantities of other species and sizes. Advice from these agencies to limit consumption of fish is mainly due to levels of PCBs, mercury, chlordane, dioxin, and toxaphene in the fish. The contaminants are listed by lake, in the following table.

Lake	Contaminants that Fish Advisories are based on in Canada and the United States
Superior	PCBs, mercury, toxaphene, chlordane, dioxin
Huron	PCBs, mercury, dioxin, chlordane, toxaphene
Michigan	PCBs, mercury, chlordane, dioxin
Erie	PCBs, dioxin, mercury
Ontario	PCBs, mercury, mirex, toxaphene, dioxin

State, tribal and provincial governments provide information to consumers regarding consumption of sport-caught fish. This information is not regulatory - its guidance, or advice. Although some states use the Federal commercial-fish guidelines for the acceptable level of contaminants when giving advice for eating sport caught fish, consumption advice offered by most agencies is based on human health risk. This approach involves interpretation of studies on health effects from exposure to contaminants. Each state or province is responsible for developing fish advisories for protecting the public from pollutants in fish and tailoring this advice to meet the health needs of its citizens. As a result, the advice from state and provincial programs is sometimes different for the same lake and species within that lake.

Future Pressures

Organochlorine contaminants in fish in the Great Lakes are generally decreasing. As these contaminants decline mercury will become a more important contaminant of concern regarding the edibility of fish.

Screening studies on a larger suite of chemicals is needed. The health effects of multiple contaminants, including endocrine disruptors, need to be addressed.

Future Actions

To protect human health, actions must continue to be implemented on a number of levels. Reductions and monitoring of contaminant levels in environmental media and in human tissues is an activity in particular need of support. Health risk communication is also a crucial component to protecting and promoting human health in the Great Lakes.

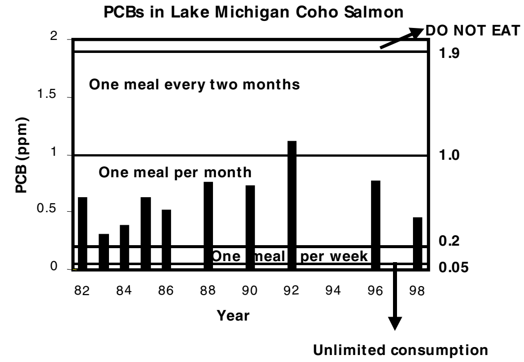
There is a need for surveillance to evaluate how much fish people eat and carry out biomonitoring to determine actual tissue levels, particularly within sensitive populations.

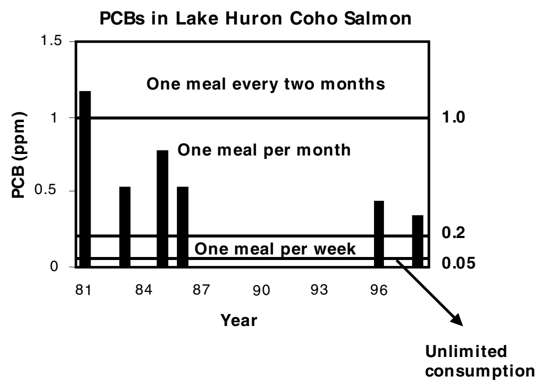
Further Work Necessary

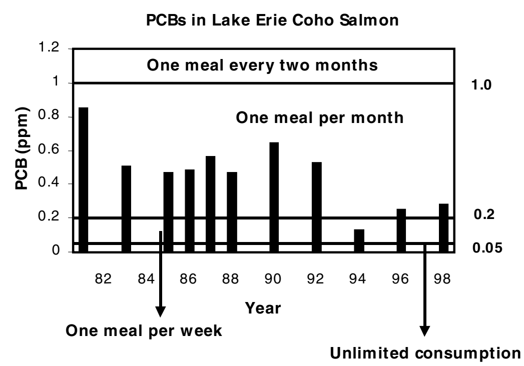
1) Evaluation of historical data: the long-term fish contaminant monitoring data sets that have been assembled by several jurisdictions for different purposes need to be more effectively utilized. Relationships need to be developed that allow for comparison and combined use of existing data from the various sampling programs. These data could be used in expanding this indicator to other contaminants and species and for supplementing the data used in this illustration.
2) Coordination of future monitoring.
3) Agreement on fish advisory health benchmarks for the contaminants that cause fish advisories in the Great Lakes. Suggested starting points are: The Great Lakes Protocol for PCBs, US EPA IRIS RfD for mercury, and Health Canada's TDI for toxaphene.

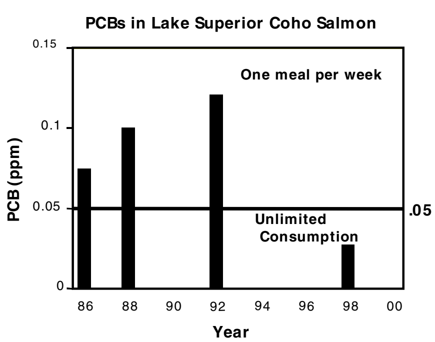
Acknowledgments

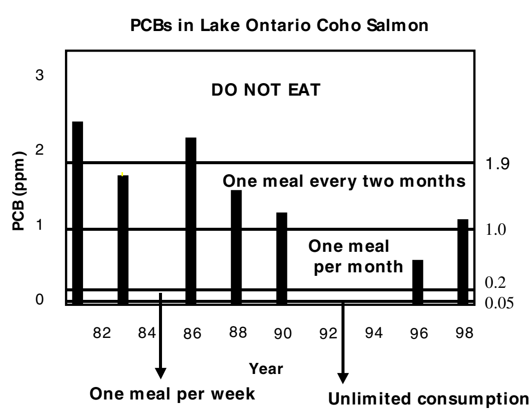
Authors: Patricia McCann, Minnesota Department of Health, and Sandy Hellman, U.S. EPA, Great Lakes National Program Office.











Drinking Water Quality

SOLEC Indicator #4175

Purpose

This indicator evaluates the chemical and microbiological contaminant levels in drinking water. It also assesses the potential for human exposure to drinking water contaminants and the efficacy of policies and technologies to ensure safe drinking water. Lastly, it evaluates the suitability of the Great Lakes as a source of drinking water. In order to effectively rate the health of the Lakes, this indicator focuses on the raw water as it flows into the water treatment plants, while also highlighting the concerns of the consumer by looking at such factors as exceeding the established drinking water standards of pathogens, taste and odor in treated water.

Ecosystem Objective

The desired objective for this indicator is that all treated drinking water should be safe to drink and free from chemical and microbiological contaminants (GLWQA Annexes 1,2,12 and 16). Water entering drinking water plants should be of high quality and have minimum levels of contaminants as is possible prior to treatment. Therefore, high quality source water is an integral part of this drinking water objective.

State of the Ecosystem

There are many facets of drinking water. This report will focus on six of those factors (Figure 1). The presence of pollutants in distributed water, as well as water from river and groundwater sources will not be examined in this report.

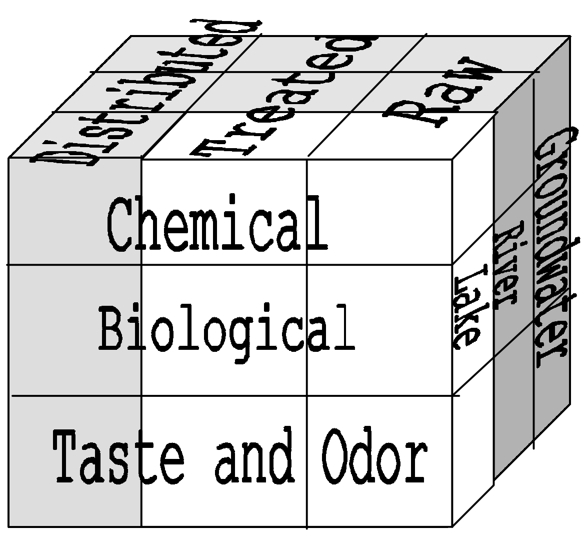


Figure 1. Drinking Water Cube, six factors are highlighted on the cube face

A focus on raw water will reflect the state of the lake waters at the treatment plant intakes, while an examination of exceeding the established drinking water standards of taste, odor and pathogens in treated water will address some concerns of the consumer. A market basket approach was used to select the water treatment plants that would represent the state of this indicator. At present there are 22 sites (Figure 2). While these sites are meant to be representative of the 5 Great Lakes, they cannot suggest a comprehensive state of the ecosystem. This year, the sites are focused on lake water intakes. In future years, the goal will be to incorporate tributaries and ground water sources of drinking water, as well as a greater number of water treatment plants for a more complete view of the status of treatable drinking water in the Great Lakes basin.

The parameters used to evaluate the state of drinking water in the Great Lakes encompass both microbiological and chemical contaminants. As was suggested at the 1999 Drinking Water Workshop sponsored jointly by SOLEC and the International Joint Commission, most of these parameters were examined in the raw water. Taste and odor, however, are most accurately measured in treated water. Additionally, there are no raw water regulations for these parameters. Therefore, methods of analysis vary.

The chemical parameters chosen were atrazine, nitrate and nitrite. These chemicals are seasonal and flow dependent. While minimal levels of atrazine, nitrate, and nitrite were detected in raw water, monthly averages and maximums fell below the federal regulations for treated water. Therefore, prior to treatment, contaminant levels in the Great Lakes water are less than maximum contaminant levels at these 22 sites as determined by plant monthly averages and maximums. However, it should be noted that although atrazine seasonally enters the lakes by way of tributaries, this pattern was not detected at the 22 intakes included here.

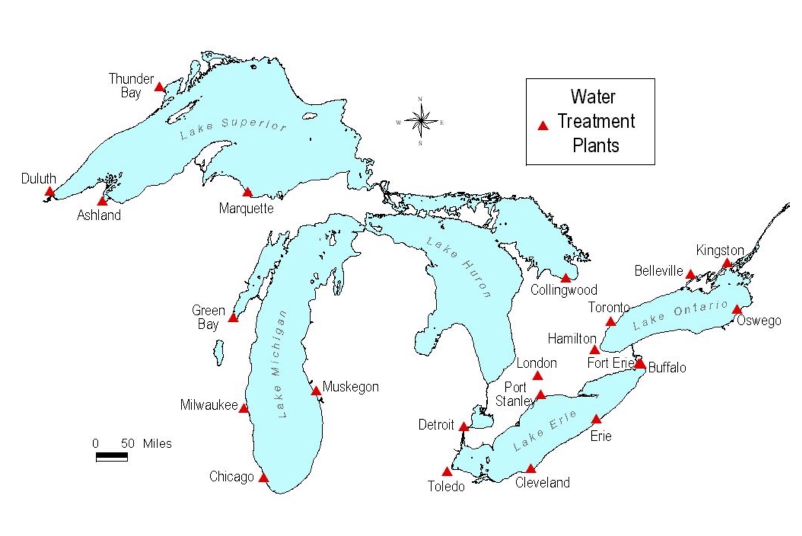


Figure 2. The 22 U.S. and Canadian water treatment plants.

The level of organic matter can be determined by examining Total Organic Carbon (TOC) or Total Dissolved Carbon (DOC). U.S. sites consistently test for TOC while Canadian sites test DOC. In the U.S., if TOC is less than 2.0 mg/L in both raw and treated water, water treatment plants can bypass certain additional treatments. The Canadian DOC for maximum level of DOC is 5.0 mg/L. The DOC concentrations in raw water at the Canadian sites were fairly low, as was TOC at the majority of U.S. sites. There were no treated water violations.

Taste and odor is a complex indicator. While it is an extremely important indicator to consumers, it is also difficult to quantitatively measure. There is no consistent test that is universally used among water treatment plants. Three possible ways to test taste and odor in treated water are the measurement of threshold odor, taste and odor panels, and the Geosmin and MIB methods that measure for the presence of odorous algae. Additionally, not all of the chosen water treatment sites had taste and odor data readily available. This indicator was evaluated for August 1999 at the six sites where data were available. Increased odor problems are usually associated with increased water temperatures. Therefore, August is usually the month of greatest odor problems. There were minimal problems with taste and odor at the six water treatment facilities that reported this parameter (Table 1).

Turbidity was chosen as a parameter for its correlation with potential microbial problems. Turbidity itself is not an indication of possible health hazards. Incoming turbidity, however, can reveal trends about possible microbiological and other contaminants. High turbidity often coincides with a higher content of microbiological organisms. This trend, however, was not analyzed for this indicator report. Turbidity values vary depending on location and lake (Figure 3). There are no raw water maximum levels for turbidity because once in the filtration plant, it can be corrected. However, by being aware of seasonal fluctuations, the treatment plants can adjust treatment for optimal removal of microbial contaminants.

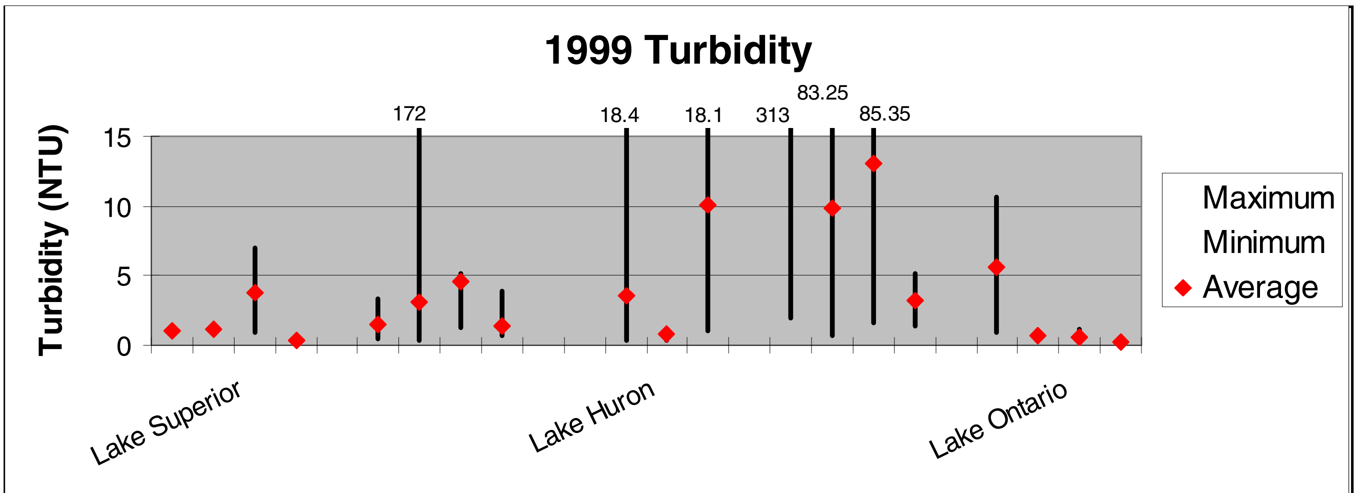


Figure 3. This graph represents the fluctuations that occur in raw water turbidity in the course of a single year. Values are based on monthly averages. Due to this, the graph is representative of possible fluctuation ranges but not conclusive of the exact turbidity for 1999.

Water Treatment Plant	August 1999 Taste and Odour
Belleville	Of the two August samples available, both had distinct odours, but not very strong
Chicago	100% taste/odour non-detected
Green Bay	100% taste/odour non-detected
London	90% taste/odour non-detected
Milwaukee	100% taste/odour non-detected
Thunder Bay	100% taste/odour non-detected

The microbiological indicators suggested are total coliform, *Escherischia coli, Giardia lambalia*, and *Cryptosporidium parvum*. The methods of analyzing water for *Giardia lambalia* and *Cryptosporidium parvum* are not the most reliable at this time but it is suggested that these remain indicators as better methods become available. *Escherischia coli* is only tested when distributed water tests positive for total coliform. Total coliform is probably the best choice for a microbial indicator at this time because it is the most uniformly tested of the pathogens. It is a required test in the U.S and Canada. An examination of the Safe Drinking Water Information System (SDWIS) of the U.S. Environmental Protection Agency and the consumer confidence reports for the U.S. sites indicate that there have been no total coliform exceedences for the last ten years. The maximum contaminant level exceedences reported by SDWIS were sampled after the treated water entered the distribution systems. If there are no exceedences in the distributed water, it can be inferred that there were no exceedences in the treated water. While the total coliform data were available for the Canadian sites, there presently is no user-friendly method for exceedence interpretation comparable to the U.S. consumer confidence reports. As of October 2000, however, Canadian treatment plants will also be required to produce this type of report. These reports are required for U.S. sites.

Use of the consumer confidence reports is extremely important. The data are presented in a more user-friendly method that is more appropriate for the needs of the SOLEC indicator. The reports are required to state if there have been any maximum contaminant levels or detections. They are not required to report on raw water data, with the exception of *Cryptosporidium parvum*.

The health of the Great Lakes, as determined by these drinking water parameters at these 22 sites, is fairly good. Chemical contaminants are consistently tested to be at minimal levels even prior to treatment. Additionally, violations of these chemical and microbial parameters are extremely rare. The risk of human exposure to contaminants is low. The quality of drinking water as it leaves the water treatment plants is good. The quality of water delivered, however, can vary due to the possibility of contaminants entering the distribution system.

Continuing Pressures

There are many pressures being placed on the sources of drinking water. Land use and agricultural runoff can negatively affect the raw water. Additionally, increases in both algal presence and water temperatures can produce "offensive" taste and odor. Byproducts of the drinking water disinfection process cause concern for some consumers. Lastly, aging distribution systems can affect the quality of already treated drinking water.

Future Activities

It is important to focus on protection of the source water. As an indicator of high quality drinking water, the state of raw water is pertinent. While the ability of the water treatment plants to treat drinking water is quite high, source water protection lowers the cost of treatment for the water plants. Analysis of raw water can reflect the actual health of the Great Lakes by using the methods already performed by the water systems.

Further Work Necessary

Unfortunately, analyzing drinking water trends basin-wide is a fairly daunting task. Due to unconformity in reporting and database management methods, it is difficult to create a cohesive report on this indicator. Additionally, the lack of electronic storage for historical data can hinder analysis of the basin-wider trends. As more treatment plants consistently report on similar tests and implement electronic data storage, these problems should be minimized.

The parameters chosen are actively used in some treatment plants while in others they currently are being worked into the system. The parameters for drinking water need to be based on water standards presently available so the data are possible to obtain and interpret as a SOLEC indicator. While consumer confidence reports can evaluate treated water detections and violations, a better method of data collection and interpretation for the extensive amount of raw water information should be established. Continual evaluation of these parameters and their relevance to both ecosystem and human health needs to be maintained. They should answer the concerns of both the water manager and the concerned consumer. The number of sites used to study the trends should be increased and these sites should be expanded to include both tributary sites and groundwater sites.

Acknowledgements
This report was assembled by Molly Madden (Environmental Careers Organization), with the assistance of Rod Holme (American Water Works Association), Pat Lachmaniuk (Ontario Ministry of Environment),Tom Murphy (U.S. EPA, Region 5), and Paul Bertram (U.S. EPA, GLNPO). Additional thanks is due to the water treatment plant operators and managers who submitted the requested data.

Air Quality

SOLEC Indicator #4176

Purpose

To monitor the air quality in the Great Lakes ecosystem, and to infer the potential impact of air quality on human health in the Great Lakes Basin.

Ecosystem Objective

Air should be safe to breathe. Air quality in the Great Lakes ecosystem should be protected in areas where it is relatively good, and improved in areas where it is degraded.

State of the Ecosystem

Overall, there has been significant progress in reducing air pollution in the Great Lakes Basin. For most substances of interest, both emissions and ambient concentrations have decreased over the last ten years or more. However, progress has not been uniform and differences in weather from one year to the next complicate analysis of ambient trends. Ozone can be particularly elevated during hot summers. Drought conditions result in more fugitive dust emissions from roads and fields, increasing the ambient levels of particulate matter.

In general, there has been significant progress with urban/local pollutants over the past decade or more, though somewhat less in recent years, with a few remaining problem districts. There are still short periods each year during which regional pollutants (primarily ozone and fine particulate and related pollutants - collectively termed smog) reach levels of concern, essentially in southern and eastern portions of the basin.

For the purposes of this discussion, the pollutants can be divided into urban (or local) and regional pollutants. For regional pollutants, transport is a significant issue, from hundreds of kilometres to the scale of the globe; formation from other pollutants, both natural and man-made, can also be important. Unless otherwise stated, references to the U.S. or Canada in this discussion refers to the respective portions of the Great Lakes Basin. Latest published air quality data is for 1997 (Canada - Ontario) and 1999 (U.S.).

<u>Urban/Local Pollutants</u>

Carbon Monoxide (CO): In the U.S., CO ambient levels have decreased approximately 46% over 1989-1998, and there are no CO non-attainment areas. Nationally, U.S. emissions decreased 36% 1990-1999, Over Canada, there has been a 30-40% reduction in composite site concentration over 1988-1997, and there has been no violation of ambient criteria from 1992-1997. Emissions have decreased 17% since 1988, but mostly over 1988-92 with newer vehicle emission standards.

Nitrogen Dioxide (NO2): Over Canada, average ambient NO2 levels remained relatively constant through the 1990's, but with no ambient criteria exceedances in 1997. Emissions (of NOx: the family of nitrogen oxides) decreased 25% from 1988-94 but have since been relatively constant. In the U.S., ambient concentrations have decreased 7% 1989-98, but remain unchanged in the Lake Michigan area. There are currently no NO2 non-attainment areas. For the U.S. as a whole, emissions (of NOx) have increased by 1% over twenty years (to 1999).

Sulphur Dioxide (SO2): over the U.S., ambient concentrations have decreased 43%, with 6 non-attainment regions in the U.S. National emission were reduced 21% (1990-99). Canadian ambient levels show only a slight decrease in the 1990's, with two violations of the one-hour criteria in 1997 (Windsor and Sudbury). Emissions decreased 78% from 1977-97), but have increased slightly from 1995-7 with increasing economic activity, though remain below the target emission limit.

Lead: U.S. concentrations decreased 48% 1989-98, and there are no nonattainment areas in the Great Lakes region. Similar improvements in Canada have followed with the usage of unleaded gasoline, with only isolated exceedances of ambient criteria near industrial sites.

Total Reduced Sulphur (TRS): this family of compounds is of concern in Canada due to odour problems, normally near industrial or pulpmill sources. Ambient concentrations are significantly lower than in 1988-90, paralleling emission reductions, though there is little trend in recent years. There are still periods above the ambient criteria near a few centres.

Particulate Matter: the U.S. Standard addresses PM10 (diameter 10 microns or less): ambient concentrations in the U.S. have decreased 20%, with six nonattainment areas in the Great Lakes region. National emissions decreased 16% (1990-99). Canadian objectives have focused on Total Suspended Particulate matter (TSP), though there is an interim Ontario PM10 objective (50ug/m3). There are still short periods with TSP levels above the objective. Emissions decreased from 1988-92, but have not decreased since. Six of the eleven ambient PM10 monitors (all in urban areas) showed exceedances of the interim objective in 1997, and, based on limited data little evident of a trend in ambient levels (1991-7). Both PM10 and TSP affect locations relatively close to pollutant sources.

Regional Pollutants

Ground-Level Ozone (O3): this is almost entirely a secondary pollutant, which forms from reactions of precursors (VOC - volatile organic compounds, and NOx, oxides of nitrogen) under sunshine; it is a problem pollutant over broad areas of the Great Lakes Basin, largely excluding Lake Superior. National assessments find some uneven improvement in peak levels, but with indications that average levels may be increasing on a global scale (NARSTO report). Local circulations around the Great Lakes can exacerbate the problem: high levels are found in provincial parks near Lakes Huron and Erie, and western Michigan is strongly impacted by transport across Lake Michigan from Chicago. In the U.S., high 1-hour concentrations have decreased 4% from 1989-98, and there are five non-attainment areas in the region. VOC emissions have decreased 20% and NOx emissions have increased 2% from 1989-98. In Canada, there has been little trend in the number of exceedances of the ozone objective in the 1990s, and mean annual levels increase. Man-made VOC emissions have decreased about 15% since 1988; NOx emissions have been constant since 1995.

PM2.5: this fraction of particulate matter (diameter 2.5u or less) is of health concern as it can penetrate deeply into the lung, in contrast to larger particles. It is a secondary pollutant, produced from both natural and man-made

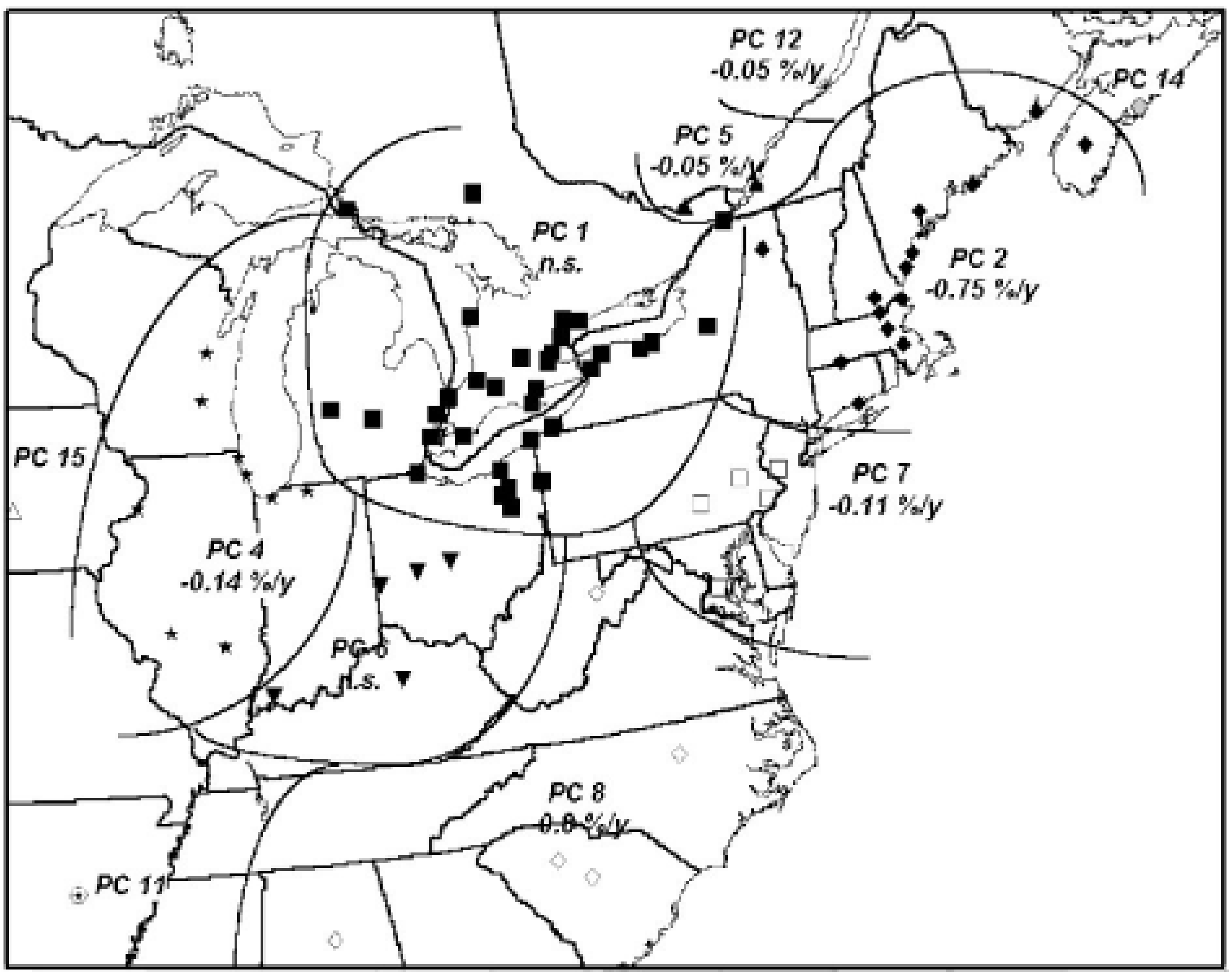


Figure 1. Regional meteorologically adjusted trends (%/yr) in 1-hr averaged O3 in the northern United States and southern Canada using cluster analysis (1980-93 data - NARSTO, 2000)

precursors. In Canada, there systematic monitoring has begun quite recently, but available data indicate that many locations in Southern Ontario will exceed the recently endorsed standard of 30ug/m3 (24-hour average). In the U.S., there are not enough years of data from the recently-established reference-method network to determine trends, but it appears that there may be many areas which do not attain the new U.S. standard.

Air Toxics: this term captures a large number of pollutants that, based on the toxicity and likelihood for exposure, have potential to harm human health (e.g. cancer) or adverse environmental and ecological effect. Some of these are of local importance, near to sources, while others may be transported over long distances. Monitoring is difficult and expensive, and usually limited in scope: usually such toxics are present only at trace levels. In both Canada and the U.S., efforts focus on minimizing emissions. In the U.S. the Clean Air Act targets a 75% reduction in cancer "incidence", and "substantial" reduction in non-cancer risks. The maximum available control technology (MACT) program has set toxic emission standards for about 50 source categories; another nine standards have been proposed. In Canada key toxics such as benzene, mercury, dioxins, and furans are the subject of ratified and proposed new standards, and voluntary reduction efforts. Some ambient trends have been found: in the U.S. concentrations of benzene and toluene have shown significant decreases from 1993-8, notably in the Lake Michigan region due to the use of reformulated gasoline. Styrene has also shown a significant decrease (1996-98).

Emissions are being tracked through the National Pollutant Release Inventory (NPRI - Canada) and the U.S. National Toxics Inventory (NTI). NTI data indicate that national U.S. toxic emissions have dropped 23 per cent between 1990-96, though emission estimates are subject to modification, and the trends is different for different compounds. In Canada, NPRI information includes information on significant voluntary reductions in toxic emissions through the ARET (Accelerated Reduction/Elimination of Toxics) program.

Future Pressures
Continued population growth and associated urban sprawl are threatening to offset emission reduction efforts and better control technologies, both through increased car-travel and energy consumption.

The changing climate may affect the frequency of weather conditions conducive to high ambient concentrations of many pollutants. There is also increasing evidence of changes to the atmosphere as a whole: average ground-level ozone concentrations may be increasing on a global scale.

Continuing health research is both broadening the number of toxics, and producing evidence that existing standards should be lowered. There is epidemiologic evidence of health effects from ozone or fine particulates down at or below levels previously previously considered to be background or "natural" levels of 30-50 ppb (daily maximum hourly values - see figure).

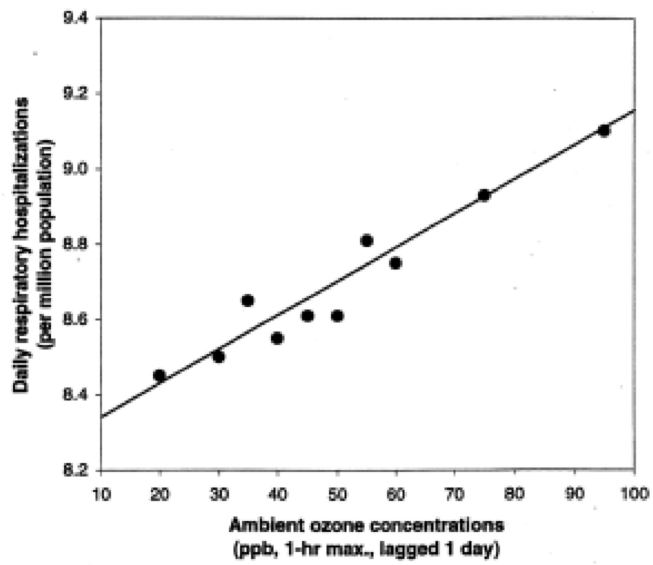


Figure 2. Association of respiratory admissions to Ontario hospitals with ozone pollution. National Air Quality Objectives for Ground-Level Ozone: Science Assessment.

Future Activities
Major pollution reduction efforts continue in both U.S and Canada. In Canada, new ambient standards for particulate matter and ozone have been endorsed, to be attained by 2010. This will involve updates at the Federal level and at the provincial level (Ontario Anti-Smog Action Plan). Toxics are also addressed at both level. The Canadian Environmental Protection Act (CEPA) was recently amended. In the U.S., new, more protective ambient air standards have been promulgated for ozone and particulate matter. MACT (Maximum Available Control Technology) standards continue to be

promulgated for sources of toxic air pollution.

At the international level, annexes to the U.S.-Canada Air Quality Agreement are in discussion, to cover pollutants such as ozone. Efforts to reduce toxic pollutants will continue under NAFTA and through UN-ECE protocols.

Future Work Necessary

PM2.5 networks will continue to develop in both countries, to determine ambient levels, trends, and consequent reduction measures. Review of standards or objectives will continue to consider new information. The U.S. is considering deployment of a national toxic monitoring network.

Limitations

It must be emphasized that this indicator report does not consider indoor air quality, or allergens. The monitoring networks are urban-focused, and are considered deficient for toxic pollutants.

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Authors: Fred Conway, Environment Canada, Meteorological Services of Canada, Downsview, ON and Joseph Chung, US Environmental Protection Agency, Air Division, Chicago, IL.